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POTENTIAL HEALTH-RELATED EFFECTS OF EXPANDED MINING OPERATIONS IN THE DECKER STUDY AREA

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POTENTIAL HEALTH-RELATED EFFECTS OF EXPANDED MINING OPERATIONS IN THE DECKER STUDY AREA

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Montana Department of State Lands and
United States Office of Surface Mining

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1. INTRODUCTION

This paper discusses how mining techniques, weather conditions, changes in the size and composition of the population, and stress due to changing occupational and community characteristics would affect health and health-related issues in both the Decker study region as a whole and at the individual mine sites. Conclusions are based on secondary data which take into consideration the soil composition, overburden, and chemical composition of coal deposits. While these results are sound, the order of magnitude of the health risks can only be established with the development of an air quality monitoring system and a forecasting model. Presumably, this system will be in place before the mining operations begin.

Chapter 2 discusses the health effects of air pollution, Chapter 3 discusses accidents, injuries, and health service demand, while Chapter 4 discusses the potential for stress-related health effects to be caused by the proposed mines. Chapter 5 provides a brief summary and identifies some of the procedures that can be used to monitor and/or address health-related issues.

2. AIR POLLUTION

2.1 Introduction

Chapter 2 discusses how the operation of more surface coal mines in the Decker area would affect the air quality of the mine sites and the region as a whole. Factors considered in making the analysis include weather conditions, soil composition, and mining techniques.

All conclusions are based on secondary data and are generally valid. In order to reach more exact statistical conclusions, the data from a monitoring system in the Decker area, soil sampling, coal analysis, and utilization of a forecasting model calibrated specifically to the local area would be necessary. This was beyond the scope of work of the task.

2.2 Factors Affecting the Problem

Expanded mining operations in the Decker, Montana study area pose two different air pollution questions:

1) Will the production of dust, particulates, and diesel fumes at the mine sites threaten the quality of air in the region; will class II ambient standards be exceeded as a result of the operations?
2) Will the production of dust, particulates, and diesel fumes at the mine sites generate a local pollution problem that may have adverse effects on the health of the mine workers or on residents who live near the mines?

If the answer to either question is yes, the conditions under which the problem would occur must be defined, and methods to assess the level of risk must be developed. To answer these questions, at least three major variables relating to the hazards of air pollution must be considered:

1) The magnitude of the mining operations and the methods of coal processing.

2) The weather conditions in the region, since they determine particulate dispersion into the atmosphere and the degree to which this dispersion will be local or regional.

3) The geology of the topsoil, the overburden, and the composition of the coal itself which will have an impact on the nature of the particulates and define the relative health hazards of this airborne material.

2.2.1 The Mining Operation

The three mining operations, the CX Ranch, the Wolf Mountain Mine, and the Youngs Creek Mine, plan to produce approximately 35 million tons of subbituminous coal annually for the next quarter-century. The three projects together would move up to 875 million tons of coal, crush it to chunks of 1 to 2 inches, store it, and then load the material on unit trains bound for shipment out of the area. In the two Decker mines (CX Ranch and Wolf Mountain), 800 million cubic yards of overburden, interburden, and topsoil would be moved and then replaced in the open pits created by coal removal (Decker Air Quality Application). The Shell Mine would probably increase that figure by 50 percent (U.S. Department of the Interior, Bureau of Indian Affairs 1981).

The mining operations would require construction of crushing plants, storage areas, haul roads, conveyors, and rail sidings. Heavy diesel-powered equipment would remove the soil, rock, and coal, transport and crush it, and finally load it onto the rail system.

The production of soil, rock, and coal particulates of all sizes and the exhaust fumes from a variety of internal combustion engines constitute the air pollution generated by the mining process. The degree to which the material would become a regional problem, a local occupational hazard, or merely a minor annoyance is related to the volume produced, the volume of hazardous minerals and chemicals in the airborne particles, the degree to which the materials are captured or abated, and the degree to which local meteorologic conditions carry the pollutants away from the mines, the workers, and the local inhabitants.

Control of the coal and noncoal particulates is as important in open pit mining as in deep mines. The Air Permit Applications for the CX and Wolf Mountain mines (Shell was unavailable at the time of writing) state that production of dust would be less than 100 pounds per hour, 1,000 pounds per day, and 50 tons per year. Certainly, the three mines taken together would add well over 50 tons of particulates to the atmosphere each year.

The pollution from the three mines, considering them as one point source, could pose a serious health hazard to workers, local residents, and those who live in the more distant communities of Sheridan, Hardin, and Billings. Detailed estimation of the potential risks to these groups requires the output from an air dispersion model for the particulates generated by the mining process. The results of the model should be available prior to the opening of the three mines. More discussion of this point follows.

2.2.2 The Soil, Overburden, Coal Components, and Diesel Exhaust

Soil, overburden, and coal may have chemical, mineral, and organic constituents that are hazardous to the health of workers. According to the Montana Health Department (Whalen and Gregory 1976), mercury may be a contaminant of the local strata. Silicon, as silicon dioxide, is common in the region. Silicon dioxide, when inhaled as a fine dust particle ($<$2 microns) can result in silicosis, a chronic pulmonary disease. Mercury, if it does exist in higher than normal quantities in the Decker area coal formations, could produce mercury poisoning in those who ingested or inhaled the material.

The coal itself is potentially pathogenic. As the material is mined, loaded, hauled, crushed, recrushed, transported, stored, and finally loaded for rail shipment, the production of fine particles of hydrocarbon material create a potential source of lung disease (Selikoff 1980). Diesel exhaust from equipment operation can also provide a source of hazardous airborne contaminants. Concern has been expressed that long-term exposure to diesel exhaust can result in increased risk of lung disease and cancer.

2.2.3 Weather Conditions

Once produced, fugitive dust would enter the local atmosphere and be dispersed in accord with factors relating to the microenvironment and regional conditions. The following three weather factors are significant:

1) Wind vector
2) Amount of precipitaion
3) Relative humidity

Each has its own effect on the degree to which the production of respirable particles during the mining operation would become a health hazard to the workers, the local community, or to the region.

The wind vector

The direction and velocity of the wind determines the direction of dispersal and the degree of dilution. Using the available data (wind vectors from the Sheridan area between 1949 and 1953), estimates for the Decker area were made. During this period, in Sheridan, the wind velocity was below 5 kilometers per hour (3 miles per hour) nearly 33 percent of the time, and below 10 kilometers per hour 56 percent of the time. If these conditions prevailed in the Decker Mine area, fugitive dust produced in mining would constitute a local hazard for most of the year.

When the wind velocity exceeds 10 kilometers per hour, the larger region must be considered. Above this velocity, however, the mineproduced pollution is diluted, and the quantity of soil and surface dust put into the atmosphere through wind erosion becomes a predominant component of the cloud of pollution. With higher velocities, the direction of wind flow is a factor in estimating the impact of pollution on the communities downwind.

The only major urban area in the region, Sheridan, is nearly due south of the mine complex and would, therefore, be under a pollution cloud 7.5 percent of the time. Hardin and Billings would be downwind of a pollution cloud from the mines even less freqently: 4.4 percent of the time (Baseline Meteorology, Appendix 8). With dispersion and dilution occurring over the twenty, fifty, and one hundred miles to the three cities, the effect on overall air quality would probably be minimal. However, without a comprehensive dispersion model, the actual impact of the mining operation on air quality in the three cities is not possible.

Local air pollution is far more significant in the Decker region than regional contamination. When wind speeds (Class 1 and 2) are low, the possibility of very high dust concentrations exists. This is especially true in the mining trenches, 150 to 200 feet below grade, where exhaust and dust may hang in an unmoving cloud. The larger particles (< 2 microns) do not constitute a pulmonary hazard because of the architecture of the respiratory tree, but the fine particles stay in the air and do constitute a pulmonary hazard.

Dragline operators, dozer and scraper operators, truck drivers, and all others who work in or near the trench or at the crushing site would be exposed to high concentrations of dust, exhaust fumes, and particulate matter. Silicon, hydrocarbons, possibly mercury, and oxides of nitrogen and sulfur have all been associated with disease production; they would all be components of the airborne particulate mass on the mine site. This mixture, if not dispersed by the movement of the wind, would be very unhealthy to breathe.

Precipitation

The amount and type of precipitation is another factor affecting the dust hazard. Low rainfall enhances the production of particulates, especially in the smaller size range. In the Decker area, precipitation in the form of rain is less than thirteen inches per year on average (sometimes as low as eight or nine inches). During the late summer and early fall (late July to mid-September) when temperatures are high, wind velocity is low, and the humidity and precipitation are low. Dust production during this period would be severe.

Fugitive dust during the winter months might also be a problem: very dry snow does not aggregate airborne particles as well as rain. While the frozen ground might reduce dust production from the haul roads and earth-moving operations, the same winter conditions might inhibit dust abatement in the crushing operation, increasing the release of fine coal particles into the atmosphere.

Humidity

The third meteorologic factor affecting particulate production is humidity, generally low in the Decker region (below 50 percent). Low humidity enhances the evaporation and sublimation of water, reducing its qualities as a mastic in soil particles. Water in the liquid phase increases the surface tension between the fine particles and the larger ones. Escape of this bound water into the vapor phase reduces the adherence of the fines, allowing them to become airborne. Again, fugitive dust would occur in highest volumes during late summer.

2.3 Areas of Concern

Fine particulate air pollution in the Decker region is an important problem for three reasons:

1) Workers in the mines might be exposed to concentrations of hazardous material, increasing their chance of chronic lung disease.
2) Local inhabitants and their livestock might also be subjected to an increased risk of chronic lung disease following exposure to the dusts generated by the operations.
3) Under certain rare conditions, the production of air pollutants from the mining sites might have an impact on the regional air quality in the Sheridan, Hardin, and Billings areas.

In all three of the above situations, the risk of pulmonary illness caused by respirable particles (<2 microns) is a function of the following three sets of variables:

1) The specific nature of the inhaled material, its chemistry, its physical size and shape, its radioactivity, and its biologic activities.
2) The concentration of the offending particles during the period of exposure; in general, higher concentrations produce more disease.
3) The aggregated time of exposure of the individual to the polluting materials; some materials will be cleared from the lung over time if further exposure does not occur, while other materials are never lost once they have been deposited in the pulmonary parenchyma.

The multiple effects of the air pollutants which could contaminate the air in the mine area will not be reiterated in this paper. Any text on environmental health, occupational illness, or preventive medicine can serve as a basic source for this information. However, the major potential air contaminants from the Decker mine sites (silicon dioxide, polycyclic and aromatic hydrocarbons present in coal and diesel exhaust, oxides of nitrogen and sulfur) are all associated with human pathology. Silicosis, "Black Lung," and the elevated morbidity and mortality in areas of high air pollution are all well documented (Harrison 1978).

Exposure concentrations are described in Public Health and Preventative Medicine (Waller 1980). From the occupational perspective, concentrations in the range of 1 to 10 milligrams per cubic meter are associated with increasing probabilities of chronic pulmonary disease.

Estimates of exposure time and concentration are not precise. Few workers have a constant, eight-hour exposure during their working life. Individuals exposed to urban pollution can find respite simply by repairing to a cleaner indoor environment. However, in either case, the measurement of particulate concentration and the duration of exposure do give crude measures of the risk of those exposed to the pollutant.

In the mining operations at the three Decker area sites, the volume of dust entering the surface atmosphere would vary throughout the year in accordance with the waxing and waning of the factors defined above, but one factor has not been well defined: the altitude to which the pollutants penetrate the local air blanket. The concentration of particulates would be much higher if only the first 5 meters above ground were polluted, in contrast to pollution of the first 100 or 1,000 meters and evenly mixed throughout that air mass. A local dispersion model, taking into consideration ground temperature, the lapse rate, the wind velocity, and the presence of special situations such as a deep trench or a closed space, is essential if an accurate assessment of the expected local pollution at the mine site is to be made.

2.4 Estimates of Air Particulate Dispersion

The available information on air particulate dispersion is not complete; however, with some assumptions, general quantitative estimates of particulate dispersion can be made. The sum of the average, nonwind-related, particulate emissions described in the Emission Inventory for the West Decker mine is 28.5 grams per second. To this figure has been added an average soil wind erosion figure of 33 grams per second. This latter figure is not very meaningful because it is not related to variations in wind speed -- zero wind would produce no air erosion of the soil, and a very high wind would produce a great deal more erosion than 33 grams per second. The same comments apply to the loss of coal dust from the open storage facilities.

The particulate production of 28.5 grams per second is based on a coal production rate of 8 million tons per year (230.1 kilograms per second). Assuming a linear relationship between coal production and the generation of airborne particulates (not a particularly good assumption, since when overburden is being removed, particulates would be generated with no coal production), the particulate emission would be equal to 123.7 milligrams per kilogram of coal produced (28.5 grams per second - 230.1 kilograms per second).

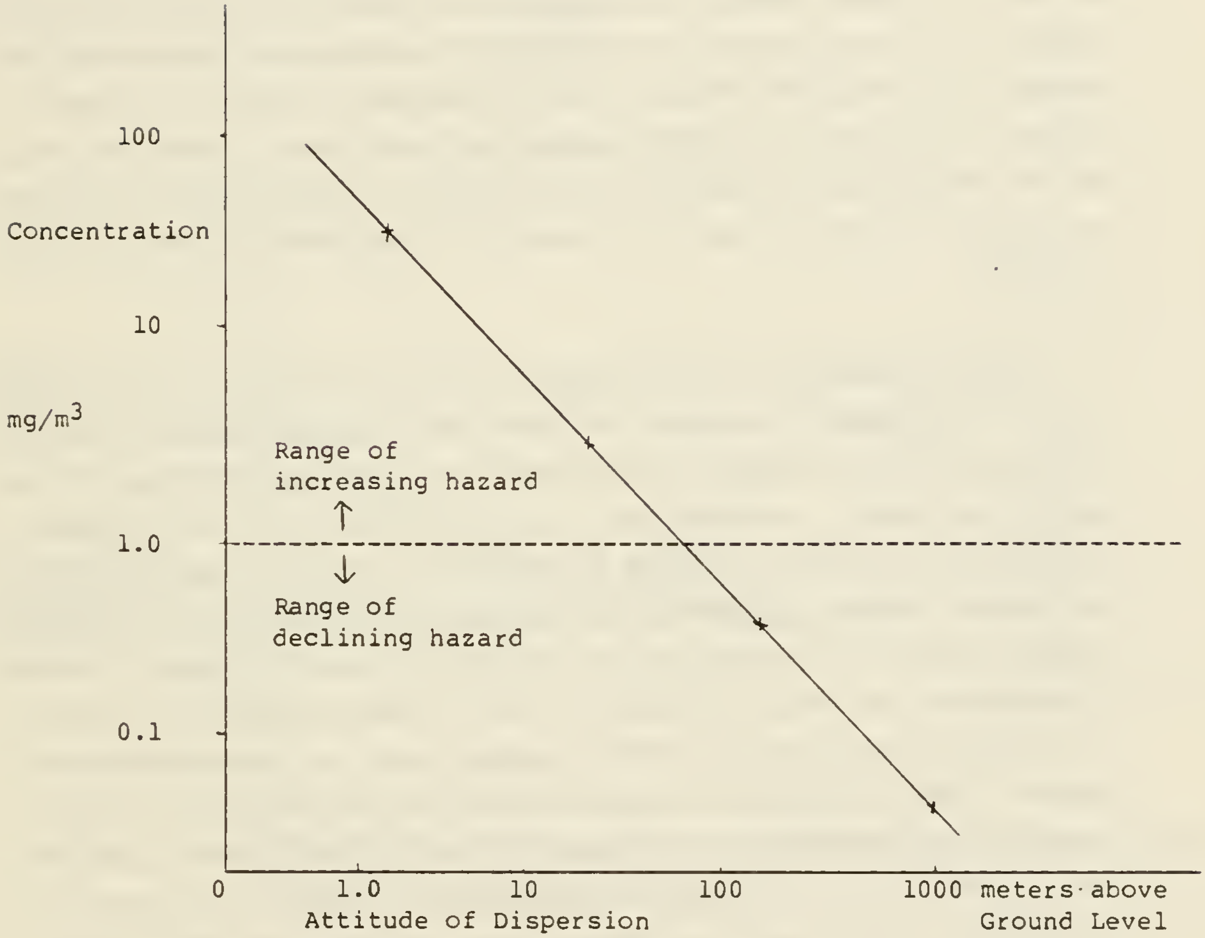
With this ratio, the total average production of particulates in the three mines can be estimated, since the total tonnage is approximately 35 million tons per year from the three sources, or 1006.8 kilograms mined per second. This value would yield, in the average second, 124.5 grams of particulates produced from the three mine sites. This figure does not include any soil raised by the wind.

The particulates would enter the atmosphere over the area on which mining activity is occurring, not the total 5,000 acres of the various sites. Assuming that the trenches, haul roads, crushing sites, loading, and storage areas constitute one square mile at each site, the affected air mass would have an area of 7.86 square kilometers (2.59 square kilometers = 1 square mile), or 7.86 million square meters into which the pollutants enter. When the wind was calm, the concentration of particulates would be a function of their upward mobility. Figure 1 shows the functional relationship between altitude of dispersion and concentration of particles after one hour of pollution. (Note the log-log relationship of Figure 1.) For the concentration to be maintained at a relatively safe concentration (below 100 micrograms per cubic meter) the rate of rise of the average particle must be at least 30 meters per hour.

Both the rate of particulate production per second and the speed with which the material gains altitude would vary widely. During the hot, dry summer months, the production of dust might increase three or four times above the 28.5 grams per second value. In a moist spring, the number could fall to 10 percent of the average value. Estimating these values is beyond the scope of this paper. Further work is necessary if accurate projections of the potential occupational exposure are to be made.

Apart from the concentration of dust in the atmosphere around the work site, the major constituents are of interest. The largest percentage by mass would probably be compounds of silicon, followed by coal dust. The low level of mercury suggested by the Montana Environmental

FIGURE 1. Concentration of Particulates per m^3 as Mine Pollution Disperse Upward



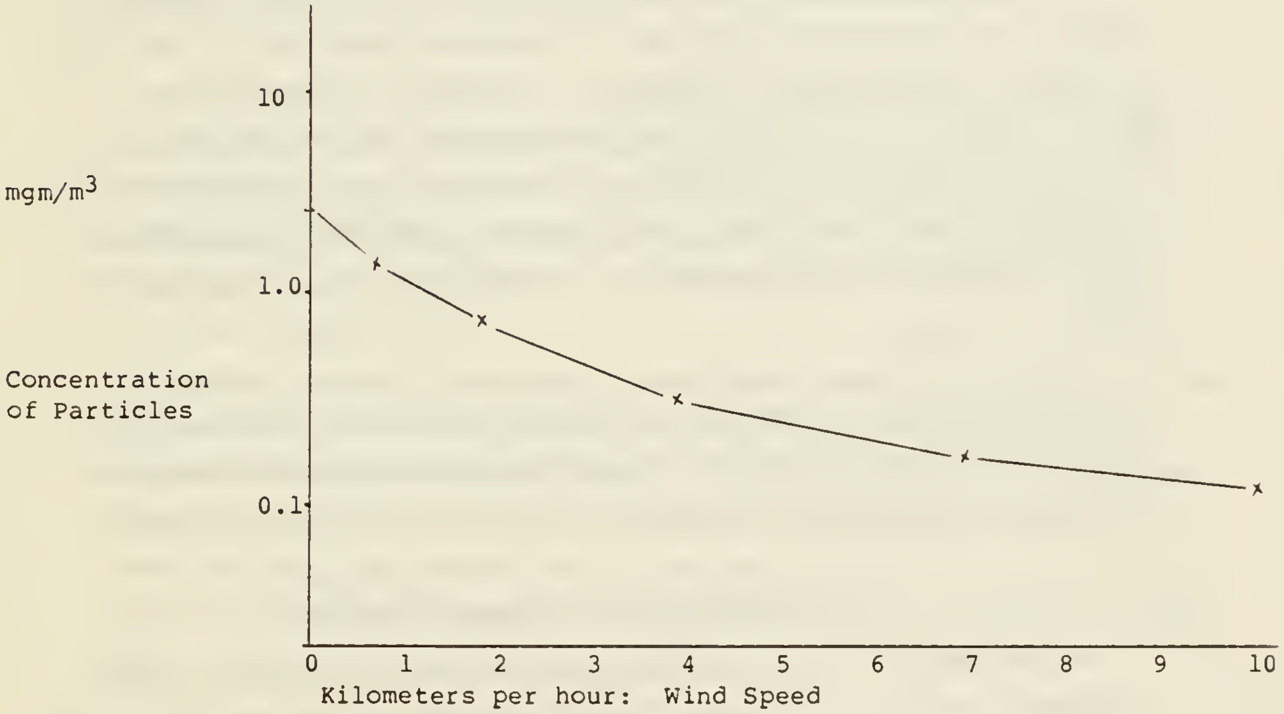
Health Report is questionable and must be evaluated. The proportion of other trace elements should be studied, as should the ratio of fines (by weight) to total airborne contaminants.

The high values noted above (those above 1 milligram per cubic meter) are in a range considered dangerous for eight-hour occupational exposure. Previous research (Selikoff 1980) indicates an increasing frequency of illness given these levels of exposure to dust. The lower values, in the 100 to 1,000 micrograms per cubic meter range, are similar to values found in polluted urban centers. They have been associated with an increased risk to a variety of lung diseases (Lave and Seskin 1977).

The above analysis has been based on the worst-case, no-wind situation. During much of the year, at least some air flow exists (1-5 kilometers per hour 33 percent of the time; 1-10 kilometers per hour 55 percent of the year). Provided that the air flow gets into the trenches, mine pollution would be diluted in proportion to wind velocity. For particulate matter rising to the 10-meter level, and assuming a laminar flow situation, the concentration would be as shown in Figure 2. After 10 kilometers per hour, the amount of particulates added to the flow by wind erosion would begin to take precedence over the minegenerated pollutants. Soil particles, if they contained silicon and trace minerals, would also be hazardous to the lungs of those exposed (Perera and Ahmed 1979). Therefore, one worst case would occur at zero wind; another would occur at very high wind speeds, when virtually all the pollution would be from soil erosion.

The hazards of particulate pollution to those who must breathe the fine particles are significant. A full dispersion model that allows accurate calculation of pollution under varying conditions in the Decker Mines area would enhance the ability of mine operations and regulators to ensure that effective actions were taken to reduce the hazard that fine particulates impose on the lungs of workers and those who live in the immediate vicinity of the mine complex. An appropriate model would

FIGURE 2. Concentration of Particulates per m^3 of Mine Pollution as a Function of Wind Speed



consider the true area over which the mine-generated pollution is added to the air. The calculations above assumed that the area was one square mile for each mine site, but this value might be too high or too low. However, it is clear is that the entire area of the site should not be used as the base of the air mass, since much of that land is not being worked at any given time. In a no-wind situation, the actual concentrations along haul roads, in the mining trench, at the crusher site, and at the loading tipple could exceed the values estimated above.

In an environmental study conducted in 1972, cited by Fairman et al. (1977), the median concentrations of respirable dust for all job classifications at surface mines were below 1.6 mg/m3, with most below 1.0 mg/m3. However, a 1972-1973 study conducted by the Public Health Service noted statistically significant increases in the prevalence of respiratory illness (specifically coal worker's pneumoconiosis (CWP) and industrial bronchitis among workers in high dust jobs. (Fairman et al. 1977).

Even if periods of exposure to high pollution are infrequent, an individual working at the site for twenty or twenty-five years could develop serious lung pathology as a result of exposure to the dust.

2.5 Summary of Air Pollution Problems

In the absence of specific data from the Decker area, and lacking the precise mathematical models needed to accurately project the concentration of fine particles and diesel exhaust at the work site under a variety of conditions, this paper can only serve to raise a number of issues that require further analysis.

The data from the literature make it clear that silicon dust, coal dust, and various other trace elements can produce disease in individuals exposed to these materials over long periods of time at concentration levels akin to those which presumably would exist in the study region.

A comprehensive study of mortality among U.S. coal miners by Rockette (published in 1977, cited in National Research Council 1981) followed 22,998 miners covered by the United Mine Workers of America health and retirement fund between January 1959 and December 1971. The mortality of miners was compared to that expected for the U.S. male population. As shown in Table 1, the miners showed statistically significant increases in death due to respiratory cancer, bronchitis, emphysema, asthma, and accidents, as well as higher rates in the categories of "ill defined" and "other" causes. These figures included miners in both underground and surface operations.

To examine the effects of exposures to diesel exhaust, the data for mines in the district covering the states of Washington, Montana, Wyoming, Utah, Colorado, New Mexico, and Alaska, (in which 95 percent of all dieselized U.S. coal mines are located) were analyzed separately. Of all ten coal mining districts in the United States; this district had the lowest death rates from all causes, from all cancers, and from cardiovascular disease; the second lowest death rates from respiratory cancer; and the third lowest death rates from digestive system cancer. However, it showed the second highest standard mortality ratio for emphysema of the ten districts, indicating that exposure to the dust and diesel exhaust from surface mining does not contribute a significant risk of lung or other cancers, but that it may pose a hazard for emphysema. (National Research Council 1981.)

In 1972 and 1973, the Public Health Service conducted a survey of the respiratory status of surface coal miners at eight mines located in Pennsylvania, Ohio, Indiana, Illinois, Kentucky, and Alabama. The survey included 1,438 miners (actually examined), 95.5 percent of the 1,505 person work force at these mines. All the miners were men. The purpose of the study was to ascertain the prevalence of coal worker's pneumoconiosis and industrial bronchitis, and to assess the prevalence and magnitude of ventilatory impairment.

TABLE 1

Observed and Expected Deaths and Standardized Mortality Ratios for Selected Causes Among U.S. Coal Miners

Cause of Death	Observed	Expected	Standardized Mortality Ratio
All Causes	7,628	7,506.1	107.6
All Cancer	1,223	1,252.2	97.7
Respiratory Cancer	373	331.5	112.5[a]
Chronic and Unqualified Bronchitis	26	31.5	82.5[a]
Emphysema	170	118.3	143.7[a]
Asthma	32	18.3	174.9[a]
Accidents	408	283.0	144.2[a]
Ill-defined	162	86.2	187.9[a]
All Other	625	459.5	136.0[a]

Source: National Research Council, Health Effects of Exposure to Diesel Exhaust, Washington, D.C.: National Academy Press 1981, p. 125. Adapted from Rockette (1977).

[a] Significantly different from expected at 5 percent level.

Of the 1,171 miners who had never worked in underground mines, only 2.5 percent showed evidence of CWP (using roentgenographic evidence). Higher rates were shown by workers with extensive underground experience (11.2 percent) and by workers with extensive work in the surface jobs where dust concentrations were highest (7.1 percent). In addition, greater dust exposure appeared to increase the prevalence of bronchitis, a problem that was substantially aggravated by smoking. Fairman et al. (1977) summarize their findings as follows:

> "Surface coal miners show little roentgenographic evidence of the development of pneumoconiosis. Smokers show small decrements in forced vital capacity with increasing exposure to surface mine dust. The possibility that an interaction between dust and cigarette smoke causes this decrement cannot be excluded. The ventilatory capacity of nonsmokers and exsmokers is not greatly altered by increasing exposure. Symptoms of chronic bronchitis increase with exposure to surface mine dust, but cigarette smoking is a more common factor. Similarly, significant airway obstruction is an uncommon finding in miners exposed solely to surface mine dust, whereas cigarettes and airway obstruction are commonly associated."

During certain times of year, the conditions of wind velocity, direction, temperature, and humidity would combine with the specifics of soil and the mining process to generate periods of high health hazard. Over the long periods of mine operation (twenty to twenty-five years), workers exposed to these conditions without relief would have a probability of lung disease greater than individuals not so exposed. To reduce the chance of unfavorable disease outcome, further evaluation of the situation is necessary. Specific actions should be devised to protect the workers during periods of high health risk.

Two concentration ranges of particulate pollution have been studied:

1) In coal and other mining operations, including granite quarrying, dust concentrations of 1,000 micrograms per cubic meter to 10,000 micrograms per cubic meter have been shown to produce an increasing probability of various pneumonconioses to workers (Last 1980). These levels could be expected at the mines in question during dry summer days, when wind velocity would be close to zero.

2) The levels of particulates normally associated with severe urban air pollution are of an order of magnitude less than noted for

> the occupational setting, falling in the range of 100 to 500 micrograms per cubic meter. At the higher levels, acute respiratory illness and death have been observed in London (Logan 1953) and Donora (Schrenk 1949). At the lower levels, long-term increased mortality has been identified (Lave and Seskin 1977). These levels are expected when wind velocity is less than 10 kilometers per hour, the air is dry, and the humidity is low.

The crude analysis of the air pollution problem generated by the mine operations seems to indicate that the regional impact of particulates would be relatively small, being overshadowed by soil wind erosion and the low probability of winds carrying the materials over any urban center. Local air pollution might, however, be a serious problem to the individuals who elect to work at the facilities during the life of the projects. These individuals deserve assurance that preventive actions would be in force when conditions existed that might produce health hazards.

3. ACCIDENTS, INJURIES, STRESS AND HEALTH SERVICE DEMAND

3.1 Introduction

This chapter discusses the increase in the demand for health care services that would result from the changes in the population and communities of the Decker area as a result of the development of the mines. These estimates are based on forecasts described in the accompanying report: Decker Area Mines Comprehensive Social Sciences Study (Mountain West Research-North, Inc. 1983).

3.2 Factors Affecting the Problem

The temporary employment of up to 495 construction workers and a continuing employment of between 1,000 and 1,900 operations workers for nearly 25 years (in the cumulative scenario -- see Table 2), along with the mine-related population growth in the area would undoubtedly cause an increase in the demand for medical care in the Sheridan area. Much of the increased demand would result from the population growth generated by the economic expansion initiated by the mines. Some of the acute demand, however, would be a direct result of the mine operation.

Four variables which could affect the volume of services demanded are considered.

1) The demographic characteristics status of the population employed at the work site and in-migrating into the area because of the mining activities.
2) The average distance traveled daily by the mine workers to and from work and their mode of travel.
3) The accident characteristics associated with surface mining activities and the level of accident prevention and safety engineering on site.
4) The likelihood that stress due to the mining operations would be sufficient to cause observable health effects.

TABLE 2

Construction and Operations Employment Schedules
by Scenarios
1985-2015

Year	KME		Consol Level 1		Consol Level 2[a]		Youngs Creek		Tanner Creek		Cumulative (KME, Consol 2, Youngs Creek, Tanner Creek)	
	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.
1985	118		8		8						134	
1986	292		128	198	128	198	50				470	198
1987	67	235	213	448	213	448	215				495	683
1988		265		538		538	325	200			325	1,003
1989		265		604		604	25	275			25	1,144
1990		265		604		604		300				1,169
1991		265		604		604		300				1,169
1992		265		604		604		300				1,169
1993		265		604		604		300				1,169
1994		265		604		604		300				1,169
1995		265		604		604		300				1,169
1996		265		247		607		300	150		150	1,172
1997		265		247	126	607		300	275	200	401	1,372
1998		265		247	213	800		300		275	213	1,640
1999		265				938		300		290		1,793
2000		265				938		300		300		1,803
2001		265				938		300		350		1,853
2002		265				938		300		383		1,886
2003		265				938		300		383		1,886
2004		248				938		300		383		1,869
2005		195				938		300		383		1,816
2006		157				938		300		383		1,778
2007						938		300		383		1,621
2008						938		300		383		1,621
2009						938		300		383		1,621
2010						938		300		383		1,621
2015						494		0		383		877

Source: Mountain West Research-North, Inc., 1982.

[a] Includes Consol Level 1 activities.

3.2.1 The Demographic Characteristics of the Mine-related Population

The health service demand created by the proposed miners will be primarily affected by the number and demographic characteristics of the additional population residing in the area due to these mines. Tables 3 and 4 show the forecast population and mine-related population effects in Sheridan and Big Horn counties for the various mine scenarios.

Although a large proportion of the mine-related population would be young (under 40) and would therefore exhibit a relatively low incidence of chronic illness, the injury rates of this population, coupled with high incidence of pre-natal, obstetrical and infant care requirements would place a moderate demand for health services on a per capita basis. Table 5 shows the rates of discharges from and days of care in nonfederal short-stay hospitals per 1,000 population for all patients in the United States in 1974 and 1979 (U.S. Department of Health and Human Services 1981).

As seen in this table, the average number of discharges for patients of all ages in 1979 was 162.8 per 1,000 population while the average bed-days of care was 1,158.2 per 1,000 population. Utilizing these figures, it appears that the mine-related population under the cumulative scenario would result in approximately 1,300 hospital stays totalling 9,200 bed-days in 2000 and about 630 hospital stays and 4,500 bed-days in 2015.

In 1979, the U.S. population averaged 3,794 visits to a physicians office or to an out-patient facility per 1,000 population. If this average holds over the forecast period for the mine induced population, 19,500 additional physician visits (to office or out-patient facility) would occur in 2000 and 14,800 additional visits would be made in 2015 due to the proposed mines under the cumulative scenario. These estimates were incorporated into the analysis of facility and service demands created by the project. To date, aside from travel and occupation-related accidents, the incoming population is not expected to exhibit unique health service requirements for their demographic profile.

TABLE 3

Population Forecasts for Alternative Scenarios
Sheridan County
1980-2015

Year	Baseline	KME	Consol 1	Consol 2	Youngs Creek	Cumulative
1980	25,040	25,040	25,040	25,040	25,040	25,040
1985	27,145	27,581	27,172	27,172	27,145	27,601
1990	28,769	29,918	31,437	31,437	29,790	33,537
1995	29,386	30,516	32,026	32,026	30,475	34,182
2000	29,704	30,808	31,232	33,869	30,770	37,273
2005	29,517	30,242	29,388	33,681	30,583	37,003
2010	31,633	31,633	31,545	35,854	32,703	38,480
2015	31,507	31,507	31,479	33,500	31,507	35,243
Difference 1980-1990	3,729	4,878	6,397	6,397	4,750	8,497
Difference 1980-1995	4,346	5,476	6,986	6,986	5,435	9,142
Difference 1980-2015	6,467	6,467	6,439	8,460	6,467	10,203
Percent Change 1980-2015	25.8	25.8	25.7	33.8	25.8	40.7
Projected Impact						
1985		436	27	27	0	456
1990		1,149	2,668	2,668	1,021	4,768
1995		1,130	2,640	2,640	1,089	4,796
2000		1,104	1,528	4,160	1,066	7,569
2005		725	-129	4,164	1,066	7,486
2010		0	-88	4,221	1,070	6,847
2015		0	-28	1,993	0	3,736

Source: Mountain West Research-North, Inc., 1982.

TABLE 4

Population Forecasts for Alternative Scenarios
Big Horn County
(Total)
1980-2015

Year	Baseline	KME	Consol 1	Consol 2	Youngs Creek	Cumulative
1980	12,180	12,180	12,180	12,180	12,180	12,180
1985	12,797	12,801	12,797	12,797	12,797	12,802
1990	13,585	13,642	13,716	13,716	13,609	13,797
1995	14,308	14,368	14,445	14,445	14,338	14,531
2000	14,966	15,027	15,007	15,178	14,996	15,305
2005	15,673	15,719	15,673	15,887	15,722	16,011
2010	16,628	16,628	16,628	16,840	16,625	16,924
2015	17,843	17,843	17,842	17,943	17,843	18,004
Difference 1980-1990	1,405	1,462	1,536	1,536	1,429	1,617
Difference 1980-1995	2,128	2,188	2,265	2,265	2,158	2,351
Difference 1980-2015	5,663	5,663	5,662	5,763	5,663	5,824
Percent Change 1980-2015	46.5	46.5	46.5	47.3	46.5	47.8
Projected Impact						
1985		4	0	0	0	5
1990		57	131	131	24	212
1995		60	137	137	30	223
2000		61	41	212	30	339
2005		46	0	214	49	338
2010		0	0	212	0	296
2015		0	0	100	0	161

Source: Mountain West Research-North, Inc., 1982.

TABLE 5

Nonfederal Short-stay Hospital Use Rates in the United States 1974 and 1979 (per 1,000 population)

Year	Discharges	Days of Care
1974	156.2	1,205.2
1979	162.8	1,158.2

Source: U.S. Department of Health and Human Services, Health United States, Hyattsville, MD, 1981, p. 166.

3.2.2 Highway Accidents and Driving Distance

Highway accidents involving the working population and their dependents would occur with regularity. Figure 3, taken from a recent AMA Report on highway accidents (Dolan 1982) shows the very high fatality rate among fifteen- to twenty-five-year-olds (4.5 per 100 million miles). Given the death rates, a group of 1,200 males in which approximately 50 percent were initially age 25 or below, driving an average of 50 miles per day to and from the mine 300 days each year, could be expected to have between 3 and 5 deaths on the highway during the first decade and at least 1 or 2 during the following decades as they grew older (but the work force grew larger). Since the probability of injury in an automotive crash is approximately 100 times the chance of death, approximately 30 to 50 injuries would occur each year on the road to and from work. Assuming that drivers in each household of the incoming population would drive another 10,000 miles each year, the death and injury figures would be expected to increase accordingly. These figures are conservative, since the individuals at risk use small cars, probably drive at excessive speeds in all kinds of weather, drink and drive, and do not wear seat belts as a matter of habit. These factors would increase the chance of automotive death and injury (Dolan 1982).

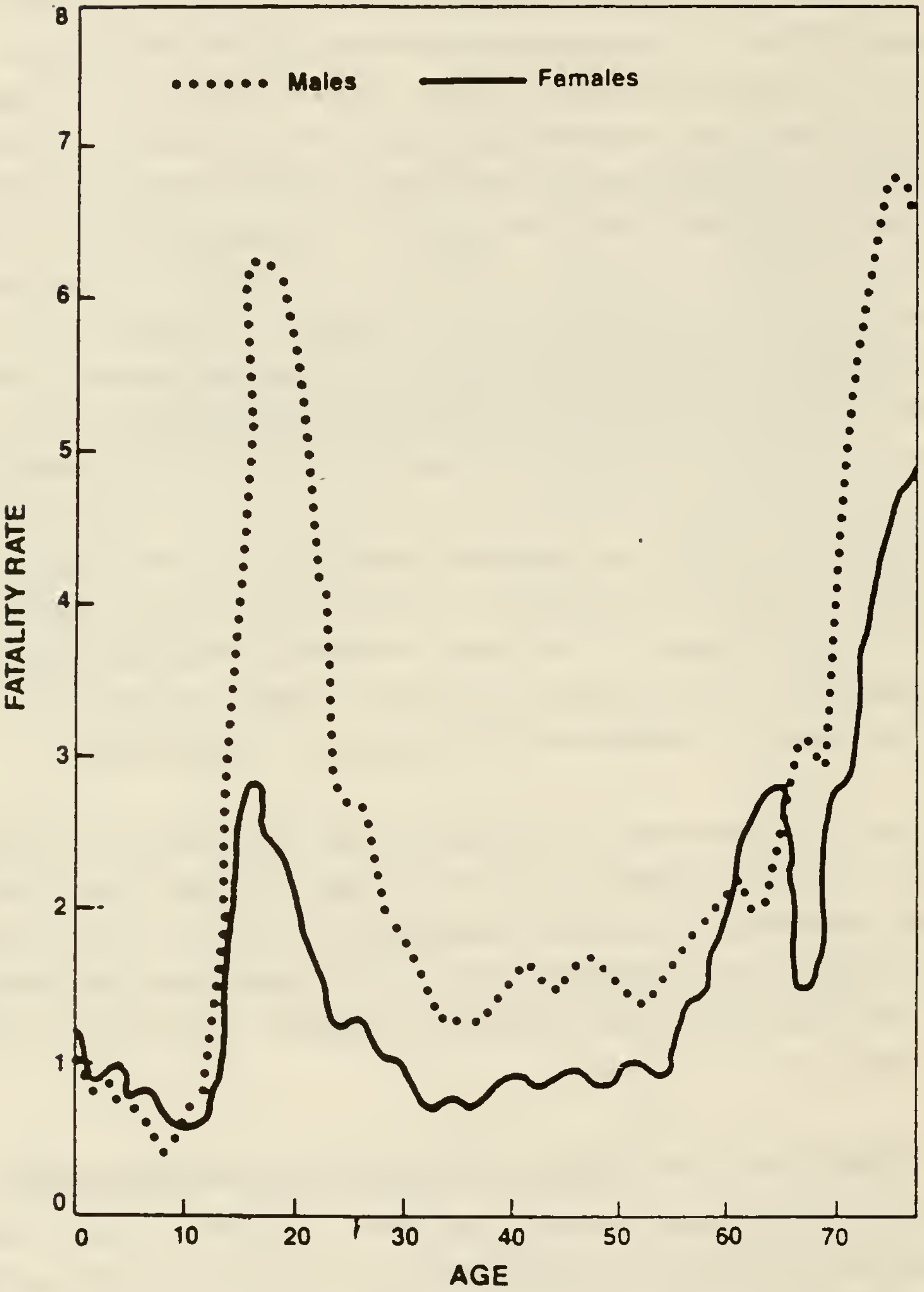
The use of motorcycles by this group might also increase the death and injury rate unless specific preventive measures were taken. For every 100 motorcycles purchased, approximately 25 would suffer a crash within the first year, resulting in 20 to 21 injured users (Weisbuch 1983). The fatality rate for motorcycle accidents is between 1 percent and 2 percent of all crashes.

3.2.3 Occupational Injury Rates and Prevention of Injuries on Site

Injuries on site must also be considered. In 1977, workers engaged in mining and quarrying had approximately 11 injuries per 100 man-years; over half (5.8 per 100) were disabling (See Table 6). For bituminous surface miners, as shown in Table 7, the frequency rate of fatal and nonfatal (but disabling) injury was 18.61 per million man-hours.

FIGURE 3

Fatality Rates per 100-Million Passenger-Miles by Age
(Smoothed over a Three-Point, Center-Weighted Mean)



Source: W.D. Dolan 1982. "Automotive-Related Injuries: Components, Trends, Prevention. American Medical Association.

TABLE 6

Occupational Injuries and Injury Rates by Type of Employment 1977

	Deaths		Disabling Injuries		Injury Rate All Reportable[b]
	No.	Rate[a]	No.	Rate[b]	
All industries	13,000	14	2,300,000	3.5	9.2
Trade	1,300	6	400,000	2.8	7.5
Manufacturing	1,800	9	530,000	4.8	13.2
Service	1,800	8	400,000	2.0	5.3
Government	1,700	11	320,000	-	-
Transportation and public utilities	1,600	33	190,000	5.0	9.8
Agriculture	1,800	53	180,000	4.7	11.2
Construction	2,500	60	240,000	5.5	15.3
Mining, quarrying[c]	500	63	40,000	5.8	11.0

Source: National Safety Council Accident Facts, Chicago, NSC, 1978.

[a] Per 100,000 workers.

[b] Per 100 worker-years or 200,000 employee hours of OSHA reportable cases in 1976 involving private industry only.

[c] Includes both underground and surface mining operations.

TABLE 7

Injury Frequency Rates for Coal Surface Mining Operations in the United States 1970-1977

Year	Fatal Injury Frequency Rates Per Million Man Hours at all Coal Surface Mining Locations in U.S.	Fatal Injury Frequency Rates Per Million Man Hours at Bituminous Coal Surface Mines in U.S.	Nonfatal Disabling Injury Frequency Rates Per Million Man-Hours at Bituminous Coal Surface Mines in U.S.	Nonfatal Disabling Injury-Severity Rates Per Million Man-Hours at Bituminous Coal Surface Mines in U.S.
1970	0.58	0.59	24.87	925
1971	0.41	0.42	25.80	428
1972	0.38	0.37	23.67	724
1973	0.28	0.30	19.88	1,342
1974	0.35	0.36	16.13	1,323
1975	0.36	0.35	17.14	906
1976	0.23	0.23	19.27	804
1977	0.24	0.24	18.37	1,310

Source: U.S. Department of Labor, Mine Safety and Health Administration, Summary of Selected Injury Experience and Worktime for the Mining Industry in the United States, 1931-1977, Denver, Colorado, 1981.

Therefore, at the Decker mines, with a work force of 1,200 workers, between 40 and 50 fatal or disabling occupational injuries might be expected each year. At peak levels of work force (year 2000), these numbers might increase to nearly 70 per year, if 1977 rates continued. However, since safety programs and preventive measures have historically been reducing accident rates, these figures should probably represent an upper limit for mines utilizing appropriate safety measures.

3.2.4 Stress-induced Health Effects

Considerable attention has been given to the identification and quantification of factors that increase stress and to the relationship between stress and health. It is generally accepted that prolonged or high levels of stress are statistically correlated with health problems. Therefore, if the proposed mine activities resulted in substantially increased levels of stress, it could be argued that they would pose a threat to the health status of area residents. The literature identifies three major mechanisms by which increased mining activities could result in increased stress and hence, diminish public health:

1) Occupational characteristics that create a stressful environment for the workers;
2) An increase in the number or intensity of life events or changes to which workers, their families, or other area residents are subjected; and
3) Actual or anticipated changes in the communities or cultures of the affected population.

3.2.4.1 Occupational Characteristics

Although demanding, surface mining occupations are not generally characterized as highly intense or dangerous. Unlike underground mining, surface mining does not pose the risk of large-scale accidents or long-term health damage (black lung disease). The health effects of coal mining have been addressed previously. Compared to nonminers of similar age and sex, stress has not been identified as a significant contributing factor for the health problems experienced by surface coal miners.

3.4.2.2 Life Events and Life Changes

During the last 15-20 years, considerable research has been undertaken to explicate the relationship between life changes or life events (residential and occupational moves, changes in family composition or relationships, etc.) stress, and mental and physical health (Holmes and Rahe 1967, Dohrenwend and Dohrenwend 1974). There have now been completed a number of studies that have demonstrated statistically significant relationships between life change characteristics and health problems. Although rapid growth communities have not been a primary focus for researchers in this area, a limited amount of information (as well as logic) indicates that residents of rapidly growing (or declining) energy resource communities experience a disproportionately high level of life changes. The argument has been made that this results in higher health risks (both mental and physical) for residents of these communities (Weisz 1979). To date, no accepted quanitification of this effect has been made, with the result that it is not yet possible to compare the adverse health effects of increased stress with the beneficial effects of higher employment and income, expanded community services, and changed attitudes toward utilizing health and helping services.

Because the rate of change expected in the Decker area is moderate, even under the cumulative scenario, existing evidence does not indicate that the growth and change caused by the mines would have a significant, adverse effect on the health of area residents.

3.4.2.3 Community and Cultural Change

Numerous authors have discussed the stresses resulting from change in social organization and cultural orientation (Albrecht 1980, Jorgensen 1978, Hackenberg and Gallagher 1972). Few have explicitly related the creation of stress from these sources to the manifestation of illness, although some work has been done addressing social change, stress, and alcohol and drug abuse.

A prerequisite for the generation of illness-inducing stress is generally asserted to be a type of social or cultural disorientation or alienation. As discussed at some length in the Decker Area Mines Comprehensive Social Sciences Study (Mountain West Research-North 1983), none of the study area communities with the possible exception of Decker are expected to undergo social or cultural changes that would be sufficient to instigate such disorientation/alienation (and hence stress and illness).

In general, most residents of the area have already been extensively exposed to coal development activities and are resigned to, if not in favor of, further development, provided it is done with care for the environment and does not occur too quickly. As discussed more fully elsewhere (American Indian Technical Service 1983), even the Crow, who would certainly experience the greatest potential cultural adjustment, expect the stress reducing effects of development -- reduced poverty, improved housing, greater tribal autonomy -- to more than outweigh the stress-enhancing effects.

In conclusion, the literature on the relationship between life changes and community and social changes with stress and individual or community health poses questions that cannot yet be answered for the dynamic, complex processes of social economic and cultural change that accompany resource development.

4. SUMMARY

The principal conclusions of this analysis can be summarized as follows:

1) The air pollution caused directly by the mining activities is not likely to pose a health threat to residents of the area communities. However, the locally high levels of air pollution at the mine site may cause increased risk of respiratory problems among workers, particularly those exposed to the highest dust level.

2) Construction and operation of surface mines results in higher levels of accident and injury than other, more sedentary occupations. However, national fatality and disabling injury statistics indicate a downward trend, and local working conditions can be made more safe by stringent and aggressive mine safety programs.

3) The expected demographic characteristics of the work forces at the newly opening mines and the commuting distance involved with mine employment are likely to result in relatively high levels of traffic accidents. The rate of accident occurence is expected to decline as the work force ages, assuming that fast patterns of employment stability are maintained. Car pooling and bus transportation would reduce the expected accident rate.

4) The increased population in the area due to the mines will result in increased traffic, especially in the Sheridan area. This will increase the number of automobile (and motorcycle-) related injuries that must be handled by local ambulance and hospital services. The scope of study did not allow examination of the potential health effects of increased air pollution in the Sheridan area due to traffic dust and exhaust.

5) The increasing population will demand additional and somewhat different health services, dependent upon its demographic characteristics. Health service needs will change as the inmigrating population ages, requiring relatively more flexible response by health service providers than in more slowly changing communities.

6) Although the early years of mine expansion will result in a population experiencing disproportionably high levels of life changes, this characteristic will diminish as the population stabilizes. Given the anticipated growth patterns, the population is not expected to experience the widespread or severe stress that has sometimes been associated with "boom" town growth. The Crow Indians, whose culture and lifestyle may undergo relatively large changes during the course of the Youngs Creek and Tanner Creek Mine activities, may be somewhat more stressed. Their response, however, will be greatly influenced

by the interpretation made of these changes and by the effects the mine activities have on employment, income, housing, and the Indian's sense of autonomy.

BIBLIOGRAPHY

Aharonson, E. F.; Ben-David, A.; and Klingberg, M.A.
1975 Air Polution and the Living. New York: John Wiledy and Sons.

Albrecht, Stan L.
1980 Unique Effects of Rapid Economic Growth Upon Different Cultural Groups: The Native American Experience. Paper presented at Coping with Rapid Growth Seminar, February, Scottsdale, Arizona.

American Indian Technical Services
1983 Crow Socioeconomic Study. Broomfield, Colo.

Baseline Meteorology; West Decker and North Extension,
Air Quality Extension, Part III, Appendix 8.

Crump, J.H.; Cooper, C.L.; Smith, M.
1980 "Investigating Occupational Stress: A Methodological Approach." Journal of Occupational Behavior 1:191-204.

Dohrenwend, B.S. and Dohrenwend, B.P., eds.
1974 Stressful Life Events. New York: Wiley.

Dolan, W.D.
1982 "Automobile-related Injuries: Components, Trends, Prevention." American Medical Association, December.

Dressler, D.M.; Donovan, J.M.; Geller, R.A.
1976 "Life Stress and Emotional Crisis: The Idiosyncratic Interpretation of Life Events." Comprehensive Psychiatry 17:549-558.

Fairman, R. Paul et al.
1977 "Respiratory Status of Surface Miners in the United States." Archives of Environmental Health 5:211.

Fireman, Stephen
1979 "A Psychosocial Model of Stress and Its Application to Managerial Unemployment." Human Relations 32:323-345.

Garrity, Thomas; Marx, Martin; Somes, Grant
1977a "The Influence of Illness Severity and Time Since Life Change on the Size of Life Change - Health Change Relationship." Journal of Psychosomatic Research 21:377-382.

Garrity, Thomas; Marx, Martin; Somes, Grant
1977b "The Relationship of Recent Life Change to Seriousness of Later Illness." Journal of Psychosomatic Research.

Graham, W.G.B.; O'Grady, R.V.; Dubuc, B.
1981 "Pulmonary Function Loss in Vermont Granite Workers." American Review of Respiratory Diseases 123:25-28.

Hackenberg, Robert M. and Gallagher, Mary M.
1972 The Costs of Cultural Change: Accidental Injury and Modernization Among the Papayo Indians.

Harrison et al.
1978 The Principles of Medicine. Fifth Edition. New York: McGraw Hill.

Holmes, T.H. and Rahe, R.H.
1967 "The Social Readjustment Rating Scale." Journal of Psychosomatic Research 11:213.

Hunter D.
1978 "The Pneumoconioses." Character 14 in The Diseases of Occupation, pp. 933-1073. London: Holder and Stonghton.

Jorgensen, Joseph G.
1978 Native Americans and Energy Development. Cambridge, Mass.: Anthropology Research Center.

Lave, L. and Seskin, E.
1977 Air Pollution and Human Health. Baltimore: John Hopkins University Press.

Levine, S. and Scotch, N.H., eds.
1970 Social Stress. Chicago: Aldine Press.

Logan, W.D.
1953 "Mortality in the London Fog Incident, 1952." Lancet 264:336-38.

National Research Council.
1981 "Health Effects of Exposure to Diesel Exhaust." Washington, D.C.: National Academy Press, p.169.

Perera, F.P., and Ahmed, A.K.
1979 Respiratory Particles: Impact of Airborne Fine Particulates on Health and the Environment. Cambridge, Mass.: Ballinger Publishing Co.

Schrenk, H. et al.
1949 Air Polution in Donora: Epidemiology of the Unusual Smog Episode of October, 1948. Public Health Service Bulletin No. 306.

Selikoff, I.J.
1980 "Occupational Respiratory Disease." Chapter 13 in Public Health and Preventive Medicine, edited by J.M. Last, Eleventh Edition, pp.610-629. New York: Appleton Century Craft.

Ster, A.C.; Wohlers, H.C.; Boubel, R.W.; Lowrey, W.P.
1973 Fundamentals of Air Pollution. New York: Academic Press.

Syme, S. Leonard; Hymen, Merton W.; Enterline, Philip.
1964 "Some Social and Cultural Factors Associated with the Occurrence of Coronary Heart Disease." Journal of Chronic Disease 17:277-289.

U.S. Department of Health and Human Services, Public Health Service
1981 Health United States. Hyattsville, MD.

U.S. Department of the Interior, Bureau of Indian Affairs
1981 Draft Environmental Impact Statement: Crow/Shell Coal Lease, Crow Indian Reservation. Billings. February.

U.S. Department of Labor, Mine Safety and Health Administration, Health and Safety Analysis Center
1981 Summary of Selected Injury Experience and Worktime for the Mining Industry in the United States, 1931-1977. Denver.

Walen, Garrison and Gregory
1976 Montana Department of Health and Environmental Science.

Waller, J.A.
1980 "Injury as a Public Health Problem." Chapter 46 in Public Health and Preventative Medicine, edited by J.M. Last, Eleventh Edition, pp 1549-1592. New York: Appleton Century Craft.

Weisbuch, J.D. et al.
1983 "The Epidemiology of Motorcyle Crashes: The North Dakota Experience." American Journal of Public Health.

Weisz, Robert
1979 Stress and Mental Health in a Boom Town. A Volume from Boom towns and Human Services, edited by Judith Davenport and Joseph Davenport III, pp.31-48. Laramie, Wyoming: University of Wyoming.

West Decker and North Decker Extension Air Quality Application, Appendix A.

APPENDIX A

TABLE A1

KME Mine Scenario
(without road)
Construction and Operations Employment Schedule
1985-2006

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1985	63	8	55	55			
1986	156	21	135	136			
1987	36	5	31	31	235	17	218
1988					265	19	246
1989					265	19	246
1990					265	19	246
1991					265	19	246
1992					265	19	246
1993					265	19	246
1994					265	19	246
1995					265	19	246
1996					265	19	246
1997					265	19	246
1998					265	19	246
1999					265	19	246
2000					265	19	246
2001					265	19	246
2002					265	19	246
2003					265	19	246
2004					248	17	231
2005					195	14	181
2006					157	11	146

Source: Mountain West Research-North, Inc., 1982.

TABLE A2

KME Mine Scenario
(with road)
Construction and Operations Employment Schedule
1985-2006

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1985	65	11	54	53			
1986	159	27	132	133			
1987	36	6	30	31	235	22	213
1988					265	25	240
1989					265	25	240
1990					265	25	240
1991					265	25	240
1992					265	25	240
1993					265	25	240
1994					265	25	240
1995					265	25	240
1996					265	25	240
1997					265	25	240
1998					265	25	240
1999					265	25	240
2000					265	25	240
2001					265	25	240
2002					265	25	240
2003					265	25	240
2004					248	23	225
2005					195	18	177
2006					157	15	142

Source: Mountain West Research-North, Inc., 1982.

TABLE A3

Consol Level 1 Mine Scenario
(without road)
Construction and Operations Employment Schedule
1985-1998

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1985	3	0	3	5			
1986	48	9	39	78	198	14	184
1987	80	15	65	133	448	32	416
1988					538	39	499
1989					604	43	561
1990					604	43	561
1991					604	43	561
1992					604	43	561
1993					604	43	561
1994					604	43	561
1995					604	43	561
1996					247	18	229
1997					247	18	229
1998					247	18	229

Source: Mountain West Research-North, Inc., 1982.

TABLE A4

Consol Level 1 Mine Scenario
(with road)
Construction and Operations Employment Schedule
1985-1998

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1985	3	0	3	5			
1986	50	12	38	76	198	19	179
1987	84	20	64	129	448	42	406
1988					538	51	487
1989					604	57	547
1990					604	57	547
1991					604	57	547
1992					604	57	547
1993					604	57	547
1994					604	57	547
1995					604	57	547
1996					247	23	224
1997					247	23	224
1998					247	23	224

Source: Mountain West Research-North, Inc., 1982.

TABLE A5

Consol Level 2 Mine Scenario
(without road)
Construction and Operations Employment Schedule
1985-2015

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1985	3	0	3	5			
1986	48	9	39	78	198	14	184
1987	80	15	65	133	448	32	416
1988					538	39	499
1989					604	43	561
1990					604	43	561
1991					604	43	561
1992					604	43	561
1993					604	43	561
1994					604	43	561
1995					604	43	561
1996					607	44	563
1997	48	9	39	78	607	44	563
1998	80	15	65	133	800	58	742
1999					938	68	870
2000					938	68	870
2001					938	68	870
2002					938	68	870
2003					938	68	870
2004					938	68	870
2005					938	68	870
2006					938	68	870
2007					938	68	870
2008					938	68	870
2009					938	68	870
2010					938	68	870
2015					938	68	870

Source: Mountain West Research-North, Inc., 1982.

TABLE A6

Consol Level 2 Mine Scenario
(with road)
Construction and Operations Employment Schedule
1985-2015

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1985	3	0	3	5			
1986	50	12	38	76	198	19	179
1987	84	20	64	129	448	42	406
1988					538	51	487
1989					604	57	547
1990					604	47	547
1991					604	57	547
1992					604	57	547
1993					604	57	547
1994					604	57	547
1995					604	57	547
1996					607	57	550
1997	50	12	38	76	607	57	550
1998	84	20	64	129	800	75	725
1999					938	88	850
2000					938	88	850
2001					938	88	850
2002					938	88	850
2003					938	88	850
2004					938	88	850
2005					938	88	850
2006					938	88	850
2007					938	88	850
2008					938	88	850
2009					938	88	850
2010					938	88	850
2015					938	88	850

Source: Mountain West Research-North, Inc., 1982.

TABLE A7

Youngs Creek Mine Scenario
Construction and Operations Employment Schedule
1986-2015

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1986	33	25	8	17			
1987	143	107	36	72			
1988	216	162	54	109	200	120	80
1989	16	12	4	9	275	165	110
1990					300	180	120
1991					300	180	120
1992					300	180	120
1993					300	180	120
1994					300	180	120
1995					300	180	120
1996					300	180	120
1997					300	180	120
1998					300	180	120
1999					300	180	120
2000					300	180	120
2001					300	180	120
2002					300	180	120
2003					300	180	120
2004					300	180	120
2005					300	180	120
2006					300	180	120
2007					300	180	120
2008					300	180	120
2009					300	180	120
2010					300	180	120
2015					300	180	120

Source: Mountain West Research-North, Inc., 1982.

TABLE A8

Tanner Creek Mine Scenario
Construction and Operations Employment Schedule
1996-2015

	Construction				Operations		
	Local			Nonlocal	Local		
Year	Total	Indian	Non-Indian	Non-Indian	Total	Indian	Non-Indian
1996	100	75	25	50			
1997	183	137	46	92	200	80	120
1998					275	110	165
1999					290	116	174
2000					300	120	180
2001					350	140	210
2002					383	153	230
2003					383	153	230
2004					383	153	230
2005					383	153	230
2006					383	153	230
2007					383	153	230
2008					383	153	230
2009					383	153	230
2010					383	153	230
2015					383	153	230

Source: Mountain West Research-North, Inc., 1982.

TABLE A9

Railroad Employment by Scenario
(Local and Non-Indian)
1985-2015

Year	KME Railroad	Consol Level 1 Railroad	Consol Level 2 Railroad	Youngs Creek Railroad	Tanner Creek Railroad	Cumulative Railroad
1985						
1986						
1987	17	25	25			42
1988	25	41	41			66
1989	25	66	66	16		107
1990	25	66	66	41		132
1991	25	66	66	66		157
1992	25	66	66	66		157
1993	25	66	66	66		157
1994	25	66	66	66		157
1995	25	66	66	66		157
1996	25		83	66		174
1997	25		83	66	25	199
1998	25		99	66	41	231
1999	25		133	66	58	282
2000	25		133	66	66	290
2001	25		133	66	75	299
2002	22		133	66	83	304
2003	22		133	66	83	304
2004			133	66	83	282
2005			133	66	83	282
2006			133	66	83	282
2007			133	66	83	282
2008			133	66	83	282
2009			133	66	83	282
2010			133	66	83	282
2015			133	66	83	282

Source: Mountain West Research-North, Inc., 1982.